

Hydrogenase activity as a proxy for hydrogen metabolism in deeply buried sediments and as a diagnostic test for life

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Microbial communities that inhabit deeply buried sediments are of considerable interest to geochemists and astrobiologists because they make up a significant fractions of the Earth's biosphere, are an important component of biogeochemical cycles, and serve as models for extraterrestrial ecosystems. Metabolic rates of these communities can be extremely low and are therefore difficult to measure directly by existing methods.

Hydrogen (H_2) is produced and utilized by a large number of microorganisms in sediments, and acts as a metabolic link between microbes with very diverse substrate requirements. The importance of H_2 suggests the hypothesis that enzymatic (catalytic) activity related to its metabolism is a good index of overall microbial community metabolism. To test this hypothesis, we have developed a radiotracer assay for *Hydrogenase*, an enzyme that all H_2 -producing and H_2 -consuming microbes possess.

Our method relies on the ability of hydrogenase to catalyze hydrogen isotopic exchange between H_2 and water. To simulate environments with low microbial activity, diluted cultures or coastal sediments are incubated under a tritiated H_2 atmosphere, sampled over time, and scintillation counted. The rate of accumulation of tritium in the water is

proportional to the amount of enzyme present. Currently, the assay can measure hydrogenase activity routinely in a 1:10,000 sediment dilution. Our present work is focused on further increasing the sensitivity of the assay. We have adapted the set-up for future deployment in an Integrated Ocean Drilling Program expedition. With appropriate modifications, this simple and sensitive technique may be applicable to planetary exploration.